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WATER QUALITY STORAGE REQUIREMENTS, MOUNTAIN PARK RESERVOIR, OTTER AND ELK CREEKS, OKLAHOMA

Public Health Service
Dallas, Texas

May 1962

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MOUNTAIN PARK RESERVOIR

OTTER AND ELK CREEKS

OKLAHOMA

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DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region VII
Dallas, Texas

In Cooperation with the

DEPARTMENT OF THE INTERIOR
U. S. Bureau of Reclamation, Region 5
Amarillo, Texas

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I. INTRODUCTION

This study was requested by letter, September 13, 1961, from the Regional Director, U. S. Bureau of Reclamation, Amarillo, Texas, to the U. S. Public Health Service, Region VII, relative to Section 2 of the Federal Water Pollution Control Act as amended by Public Law 87-88, 87th Congress, July 20, 1961. This Section requires Federal agencies surveying or planning reservoirs to consider "storage for regulation of streamflow for the purpose of water quality control." This Section also requires the agencies to obtain the advice of the Secretary of Health, Education, and Welfare on the "need for and value" of such storage.

The Bureau's request refers specifically to the Mountain Park Reservoir project on West Otter Creek, Kiowa County, Oklahoma.

Successful completion of this study would not have been possible without the assistance of organizations who gave counsel and technical advice and made their files, publications, and records available.

Special appreciation is expressed to the following organizations:

Oklahoma State Department of Health, Oklahoma City, Oklahoma

Oklahoma Water Resources Board, Oklahoma City, Oklahoma

U. S. Bureau of Census

U. S. Bureau of Reclamation

U. S. Geological Survey

II. SUMMARY AND CONCLUSIONS

Summary

1. The study area is located in extreme southwestern Oklahoma and includes the Salt Fork of the Red River and Otter and Elk Creeks.

2. Mountain Park Reservoir on West Otter Creek will be the first part of a two-stage development. The second stage, not to be constructed now, will be a diversion dam on Elk Creek and a canal to Mountain Park Reservoir.

3. The complete Mountain Park project will yield 16.6 million gallons per day (mgd) for municipal and industrial water supply purposes. Communities in the service area are Altus, Snyder, and Frederick. The Bureau reports that Altus will use 10.0 mgd and Snyder 0.76 mgd in the year 2015. Storage yielding 2.0 mgd was initially set aside for Frederick; however, that city does not plan to contract for water at this time.

Conclusions

1. To maintain acceptable water quality in Otter Creek below Snyder (assuming 1953 conditions will reoccur by 2015), a flow of 1.0 mgd must be provided. This amount of water could be obtained from storage originally allocated to Frederick. The annual benefits from storage for quality control are calculated to be $2,100.

2. To maintain acceptable water quality in the Salt Fork of the Red River below Altus a flow of 27.5 mgd must be assured. Annual benefits from storage for quality control purposes are $29,400.

3. Wastes from the community of Roosevelt will be discharged into the headwaters of Mountain Park Reservoir. These wastes are not expected to be harmful to the reservoir if they are detained for a suitable time before discharge - usually 60 days. The State of Oklahoma Department of Health accepts this practice.

4. Wastes from Hobart will not be a factor in the Mountain Park project until the second stage of construction comes under consideration. If present conditions are allowed to persist, Hobart's wastes would go into the Mountain Park Reservoir through the Elk Creek diversion canal thereby creating a pollution hazard. To eliminate this hazard, Hobart's outfall line should be extended to a point below the diversion dam when the second stage of the Mountain Park project is constructed.

III. DESCRIPTION OF PROJECT

The Mountain Park Reservoir will be located on West Otter Creek near Mountain Park, Oklahoma, in Kiowa County. See Figure 1. It will be the first part of a two-stage development, the second stage being a diversion dam on Elk Creek and a canal to the Mountain Park Reservoir. The second stage is not planned at this time.

Most storage in the Mountain Park Reservoir will be used to meet municipal and industrial water requirements in the area, and, upon completion of both stages, the project will have a firm yield of 16.6 mgd for these purposes. The Bureau reports that by 2015, the communities of Altus and Snyder will use 10.0 mgd and 0.76 mgd, respectively, from Mountain Park Reservoir. Storage to yield 2.0 mgd was initially set aside for Frederick; however, that city does not plan to contract for water at this time.

After 100 years of sedimentation, the Mountain Park Reservoir will have the storage characteristics as shown in Table III-1.

Table III-1

Storage Characteristics
Mountain Park Reservoir, Oklahoma

Item	Pool Capacity (acre-feet)	Top of Pool Elevation (feet, msl)
Surcharge Pool	101,374	1,425.40
Flood Control Pool	20,031	1,413.93
Conservation Pool	88,455	1,411.00
Dead Storage	3,803	1,386.32

Flows of Otter and Elk Creeks are very erratic and many days of zero flow are experienced. Runoff is entirely dependent upon rainfall. Rainfall varies from 10 to 50 inches per year and precipitation records indicate that the critical low period was between 1951 and 1955.

Water quality data for Elk Creek are limited to the period from October 11, 1949, to September 30, 1951, when a daily sampling station near Hobart was in operation. These data and the quality of water supplies for cities in the area are shown in Table III-2.

Water quality data for Otter Creek are limited to several spot samples. Four spot samples at Lake Snyder indicate dissolved solids vary from 90 to 530 ppm; total hardness from 51 to 285 ppm; chlorides from 51 to 108 ppm; and sulfates from 17 to 92 ppm. These four samples can only serve as a general indicator of water quality.

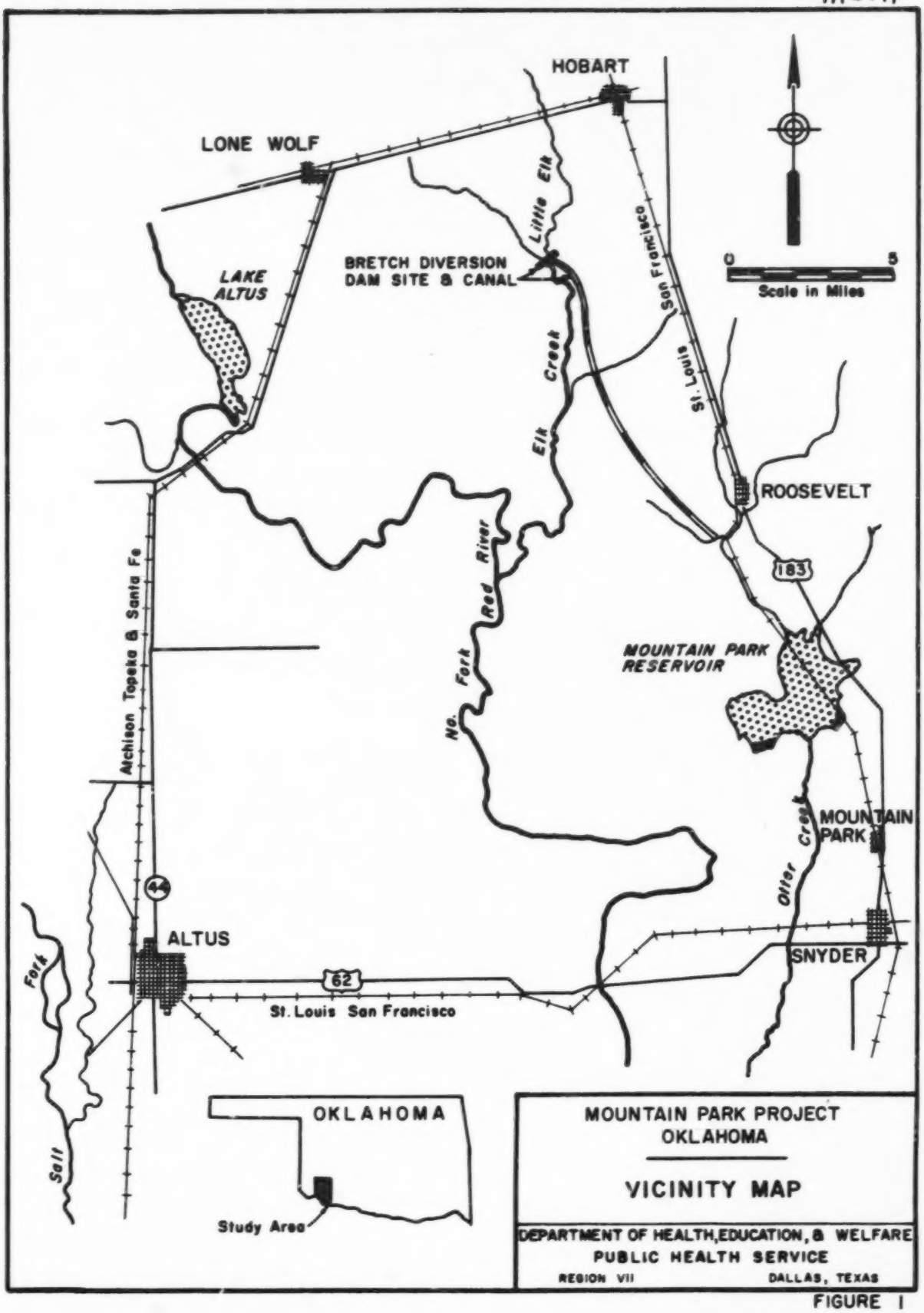
HOBART
LONE WOLF
LAKE ALTUS
BRETCH DIVERSION DAM SITE & CANAL
Little Elk
San Francisco
St. Louis
Elk Creek
Red River
No. Fork
ROOSEVELT
183
MOUNTAIN PARK RESERVOIR
Atchison Topeka & Santa Fe
MOUNTAIN PARK
Otter Creek
44
ALTUS
62
SNYDER
St. Louis San Francisco
Fork
Salt
0
5
Scale in Miles
OKLAHOMA
Study Area
MOUNTAIN PARK PROJECT
OKLAHOMA
VICINITY MAP
DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII
DALLAS, TEXAS

FIGURE 1

Table III-2

Water Quality Information
(Concentrations in ppm)

	Elk Creek Near Hobart			Present Municipal Supplies*			PHS Drinking
	Maximum	Minimum	Weighted Average	Altus	Frederick	Snyder	Water Standards
Total Dissolved Solids	1,710	209	422	1,230	536	207	500
Total Hardness	1,020	109	259	606	214	490	---
Noncarbonate Hardness	614	14	113	490	0	87	---
Chlorides	186	6	27	215	69	328	250
Sulfates	722	43	139	522	52	207	250

* Altus presently obtains water from Altus-Lugert Reservoir, and wells are the source of supply for Frederick and Snyder.

IV. DESCRIPTION OF PROJECT AREA

The project area lies in the extreme southwestern corner of Oklahoma. See Figure 1. It encompasses the Salt Fork of the Red River and Otter and Elk Creeks, which are tributaries of the North Fork of the Red River.

Valleys in the area are characterized by meandering streams bordered by long stretches of very flat land. The topography is rolling with exception of the Wichita Mountains, which are adjacent to the study area. Granite and limestone are the principal minerals in the area, and some industrial concerns have developed which supply these minerals to the building industry.

The area is primarily agricultural. Temperatures and climate are mild and permit a growing season of about 225 days. Manufacturing is for the most part related to farm products and is centered in Altus, Frederick, and Hobart. One animal slaughtering and processing plant which handles about 70 animals per week is located at Hobart. Other communities are centers of local trading in agricultural machinery and farm products. Most land is under cultivation; the primary crops are cotton and wheat.

The relative size of the various sectors of the economy are shown in Table IV-1. With the exception of Altus, communities of the area have experienced no great increase in population. Populations for towns and cities in the area are shown in Table IV-2.

Table IV-1

Distribution of the Labor Force
In Kiowa and Jackson Counties, Oklahoma - 1960

Item	Number	% of Total Labor Force
Total Labor Force	12,916	100
Farm	2,635	20.4
Mining	180	1.4
Manufacturing	577	4.5
Resource-Oriented	238	
Food and Kindred	165	
Stone, Clay, and Glass	69	
Other Nondurable	4	
Nonresource-Oriented	339	
Fabricated Metals, Machinery	177	
Textiles	4	
Printing, Publishing	158	
Services	8,861	68.6
Unemployed	663	5.1

Table IV-2

Population Trends of Jackson, Kiowa, and Tillman Counties 1930-1960

	Total Population				Percent Change for Decade			Percent Rural			
	1930	1940	1950	1960	1930-1940	1940-1950	1950-1960	1930	1940	1950	1960
Jackson Co.	28,910	22,708	20,082	29,736	-21.5	-11.6	+48.1	70.8	62.2	51.5	28.6
Altus	8,439	8,593	9,735	21,225	+ 1.8	+13.3	+118.0				
Kiowa Co.	29,630	22,817	18,926	14,825	-23.0	-17.1	-21.7	83.2	77.3	71.5	65.4
Mt. Park	459	441	418	403	- 3.9	- 5.2	- 3.6				
Snyder	1,195	1,278	1,646	1,663	+ 6.9	+28.8	+ 1.0				
Roosevelt	721	744	679	495	+ 3.2	- 8.7	-27.2				
Tillman Co.	24,390	20,754	17,598	14,654	-14.9	-15.2	-16.7	81.3	75.4	68.9	59.9
Frederick	4,568	5,109	5,467	5,879	+11.8	+ 7.0	+ 7.5				

Snyder

Snyder is located in Kiowa County about five miles southeast of the proposed Mountain Park Reservoir at the junction of Federal Highways 62 and 183. See Figure 1.

Snyder is predominantly a trade center for the surrounding agricultural area. Industrial activities include two granite fabricating plants and a nearby missile launching base.

Snyder's population increased from 1,278 in 1940 to 1,646 in 1950 and experienced a lesser increase to 1,663 in 1960. See Table IV-2. Operation of the local missile base and a probable increase in granite fabricating activities are expected to influence Snyder's growth in a manner described by Reid, Treat, and Wilson. 1/ Snyder's population is expected to reach 3,800 in the year 2015.

The city now obtains its water from five wells, three of which are considered standby. Snyder Lake served as the water supply until its abandonment in 1958 due to insufficient yields and pipeline deterioration.

Snyder requested the Bureau of Reclamation to supply 0.76 mgd from the Mountain Park project, an amount sufficient to meet their needs to the year 2015. Their present source will be retained to meet peak demands.

In 1958 Snyder supplied 1,900 persons with an average of 0.25 mgd, amounting to a daily use of about 132 gallons per capita. Snyder's 1958 average sewage flow was 0.20 mgd or 80 percent of the water demand. The sewage flow is expected to be reduced to 70 percent of the average water demand when a plentiful source of water is assured. This decrease is attributable to expected increases in granite fabricating, lawn watering, and other uses which do not discharge waste waters to the community's sewerage system.

At the present time the sewage treatment plant achieves a 70 percent reduction in the biochemical oxygen demand (BOD) and discharges the effluent to an open ditch which flows about two miles to Otter Creek. It is assumed that, as the city grows, new sewage treatment facilities will be installed which will assure a 90 percent reduction in BOD and the effluent will be carried to Otter Creek in a closed conduit.

It was found that dilution water in the amount of 0.4 mgd (0.62 cfs) in the year 1975 and 1.0 mgd (1.55 cfs) in the year 2015 will be required to maintain a dissolved oxygen concentration (DO) of 4.0 ppm in Otter Creek below Snyder. This can be obtained from storage originally allocated to Frederick.

The most feasible, equivalent, alternative means of water quality control would be the stage construction of a lagoon system. On this basis, the annual benefit of storage in the Mountain Park Reservoir for water quality control in Otter Creek below Snyder is $2,100.

When the water table at Otter Creek drops sufficiently, reservoir releases are lost. It is recommended that dilution water be held until the water table is high enough to assure maximum benefit of reservoir releases.

Altus

Altus is located in Jackson County about 20 miles west of the proposed Mountain Park Reservoir at the junction of Federal Highways 62 and 83. See Figure 1.

Industrial development is relatively limited and is for the most part dry. Altus Air Force Base and several missile launching bases are located at or near Altus.

The population of Altus increased from 9,735 in 1950 to 21,225 in 1960, about 118 percent. This growth is evidenced by an expanding building industry from missile base construction and maintenance of the Altus Air Force Base. Altus Air Force Base was reactivated and made a permanent installation in 1952.

Based on work by Reid, Treat, and Wilson, 1,2/ the population of Altus is expected to be 49,000 in 1975 and 67,000 in 2015.

Altus has an allocation of 4,800 acre-feet annually from Altus Reservoir. After surface reservoir losses near town, 3.42 mgd will be available to the city. When use exceeds that amount, additional water will be obtained from Mountain Park Reservoir - 4.04 mgd in 1975 and 10.0 mgd in 2015. The city now obtains 3 mgd from Altus Reservoir.

The Altus sewage treatment plant achieves a 73 percent BOD removal. About 72 percent of the average water demand reaches the sewage plant as waste water. The sewage plant effluent is discharged to a small creek which parallels the Salt Fork of the Red River. By extending the outfall line one-quarter mile, the effluent could be discharged to Salt Fork, thereby taking advantage of that stream's greater flow. Plans are now under way to modify the existing plant and to construct an aerated lagoon system.

It was found that dilution water in the amount of 16.5 mgd (25.6 cfs) in the year 1975 and 27.5 mgd (42.6 cfs) in the year 2015 will be required for water quality control in the Salt Fork below Altus.

It was assumed that lagoons offering a detention period of 30 days, following a 90 percent reduction of BOD, would control quality in the receiving stream in a manner equivalent to dilution. Stage construction of five lagoons would have an annual cost of $29,400 based on the same 50-year period as the economic life of the Mountain Park Reservoir.

Roosevelt

Roosevelt (1960 population of 495) is located in Kiowa County at the headwaters of the Mountain Park project.

The community obtains its water from 10 wells, supplying 800 people at a rate of 0.15 mgd. It also provides sewerage facilities for 600 persons. Sewage flows vary from 0.07 mgd to 0.08 mgd and treatment consists of primary settling followed by two lagoons. Wastes from the 800 residents of the Roosevelt area can be sufficiently reduced in bacteria by 60-day detention ponds and, therefore, will not present a pollution hazard to the Mountain Park project.

Hobart

Hobart is located in Kiowa County about 20 miles north of the Mountain Park Reservoir. It had a 1960 population of 5,132. See Figure 1.

The Mountain Park Reservoir will not be affected by wastes from Hobart until the second stage of construction is begun. The second stage consists of a diversion dam below Hobart on Elk Creek and a canal to Mountain Park Reservoir. Under present conditions, Hobart will discharge wastes which would flow through the diversion canal to the Mountain Park Reservoir, thereby creating a pollution hazard. In order to eliminate this hazard, it is recommended that Hobart's outfall line be extended to a point below the diversion dam when the second stage is constructed.

V. APPENDIX

VA

EXHIBIT A

Procedure for Calculating Water Quality Requirements

Using the oxygen sag equations of Streeter and Phelps, an amount of dilution water was determined which would maintain a dissolved oxygen concentration of 4.0 ppm at the critical point.

For purposes of this report, the following parameters are assumed:

1. Future wastes will receive a 90 percent reduction of BOD before discharge.

2. The BOD rate coefficient is taken as 0.10 per day.*

3. The reoxygenation rate is taken as 0.16* per day in Otter Creek below Snyder and 0.14* per day in Salt Fork below Altus.

4. The benthal deposit oxygen demand is assumed zero in Otter Creek and Salt Fork.

5. The initial stream DO is taken as 80 percent of saturation at a temperature of 25°C below Snyder and 30°C below Altus.

6. The initial stream BOD, due to natural organic loadings, is taken as 2.0 ppm in both Otter Creek and Salt Fork.

7. Sewage treatment plant effluents are assumed to have a DO of 2.0 ppm. 3/

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* All rate coefficients apply to first order, base 10 reactions.

VI. BIBLIOGRAPHY

1. Reid, G. W., Treat, G. B., and Wilson, F. J., "Population Estimates for the State of Oklahoma," Paper 1136, Transactions ASCE 83:1, 1957.

2. Reid, G. W., Treat, G. B., and Wilson, F. J., "Future Water Requirements in Oklahoma," p. 1357, AWWA Journal, Volume 51, 1959.

3. Keefer, C. E., Sewage Treatment Works, McGraw Hill, New York, First Edition, 1940.